

BA/WTR  
WR CO  
Mail Stop 60189

Initial	Date
aw	6-10-97
Ca	6-10-97

JUN 10 1997

To: Refuge Manager, Arapaho National Wildlife Refuge, Walden, Colorado

From: Refuge Hydrologist, Division of Water Resources, Region 6

Subject: Field Inspection of Mainstem Diversion Flumes

Last year W.W. Wheeler & Associates completed our contracted report on current consumptive use of the Refuge lands compared to the consumptive use of the same lands when privately owned. This report suggested that some of the flumes were not operating properly. On May 28, 1997, three Colorado state employees (Eric Wagner, Kent Holt, and Kade\_\_\_\_) accompanied me on a field inspection of flumes located on main diversions for the Refuge. The attached table summarizes status of the flumes that were observed in 1996 by Ivan Walter, and again in 1997 by our group.

This inspection was conducted during high flow conditions (130% of normal snowpack). Most of the flumes have settled and were submerged. Although the State thought it was unlikely, it is possible that some flumes may perform closer to their rating in lower flow conditions. The North Park climate includes harsh winters that result in severe frost heave conditions that could contribute to the high maintenance requirement for these flumes at the Refuge. We discussed the possibility of a continual rotation program to replace or reset flumes.

I had planned to rate the flumes with a flow meter, but State personnel advised against this because channel conditions will change so much throughout time, with plant growth especially, so the rating would not be reliable. The State's extensive experience measuring faulty flumes has resulted in an easy verification process (see attached methodology). The State has tested and endorses this method. I would suggest using it often to verify flows. Most time is consumed in getting to the structure, but once the staff is at a structure it takes ten minutes or less to conduct the Chip Test. Predicted flow in the flumes was consistently higher than measured flow, so it appears that we are overestimating Refuge water use.



I suggest a meeting with Refuge staff, water rights specialists, and myself to coordinate plans and prioritize a schedule for reestablishing flumes in conjunction with other ongoing water rights issues. Our division has funds in our proposed 1999 budget to automate water data collection and to develop a water budget to assist resource management. We also need to include the development of a budget and construction schedule for modification of these flumes.

Attachments

cc: Regional/Refuges Contact  
Eric Wagner

bcc: WR rf  
RO rf

WTR:JVarner:ca:6/10/97

*Cheryl Willis*

*for* /s/ JANA VARNER



Arapaho National Wildlife Refuge Condition of Measurement Flumes			
Ditch	Size of Flume	Condition Ivan Walters 1996	Condition May 1997
Antelope No. 1		no flume	
Boyce Brothers	4 ft	ditch not clean upstream, submerged	
Dryer Ditch		not checked	
Everhard Baldwin		not checked	
Hill & Crouter	2 ft	ditch not clean, submerged	staff gage on bank, not level, very submerged, willow problem
Home #1 & Upland	2 ft	not level	looks lower on upstream end
Howard Ditch	8 ft	good	
Hubbard #1 Ditch	2.5 ft	operates submerged ditch not clean downstream	headgate closed, flow line indicates submergence, raise 4", reattach wingwalls so they don't have to be moved
Hubbard #2 Ditch			put rock or sod in the big hole next to flume on the approach, ditch needs cleaning, water moving slower on right side measured = 57 cfs predicted = 52.5 cfs
Hubbard #3 Ditch			
Hubbard #4 Ditch	no flume		
Hubbard /Caudle			
Ish & Baldwin	no flume		
Macfarlane Extension			



Midland Hackley Ross Ditch	5 ft	not level	
Midland Hackley	18 in.	good	laterals weren't observed
Midland Ross Ditch	no flume		
North Park #6	4 ft no staff gage	water marks indicate flume working properly	is working measured = 5.3 cfs predicted = 5.06 cfs
Oklahoma #1	5 ft	flume not level	set too low, raise 4" to 6", consider moving downstream below the large leak of wastewater from the Midland ditch measured flow = 25 cfs predicted flow = 40 cfs
Oklahoma #2	3 ft	settled in front	set too low
Potter Ditch		no flume	
Riddle Ditch	4 ft	not level & not aligned	set too low, raise 4 - 6", measured = 5.4 cfs predicted = 9 cfs
Ward # 1	4 ft	okay	
Ward # 2		no flume	
Ward # 3	3 ft	square wooden headgate	submergence created by grasses in channel, needs to be raised 4".





Hill & Crouter



Home #1 & Upland

2 ft

ditch not clean, submerged

staff gage on bank, not level,  
very submerged, willow  
problem



Home #1 & Upland

2 ft

not level

looks lower on upstream end



Hubbard #1 Ditch

operates submerged  
ditch not clean downstream

headgate closed, flow line  
indicates submergence, raise 4",  
reattach wingwalls so they  
don't have to be moved

2.5 ft

Hubbard #2 Ditch

put rock or sod in the big hole  
next to flume on the approach,  
ditch needs cleaning, water  
moving slower on right side  
measured = 57 cfs  
predicted = 52.5 cfs

North Park #6

4 ft  
no staff gage

water marks indicate  
flume working properly

is working  
measured = 5.3 cfs  
predicted = 5.06 cfs





flume not level

set too low, raise 4" to 6",  
consider moving downstream  
below the large leak of  
wastewater from the Midland  
ditch  
measured flow = 25 cfs  
predicted flow = 40 cfs

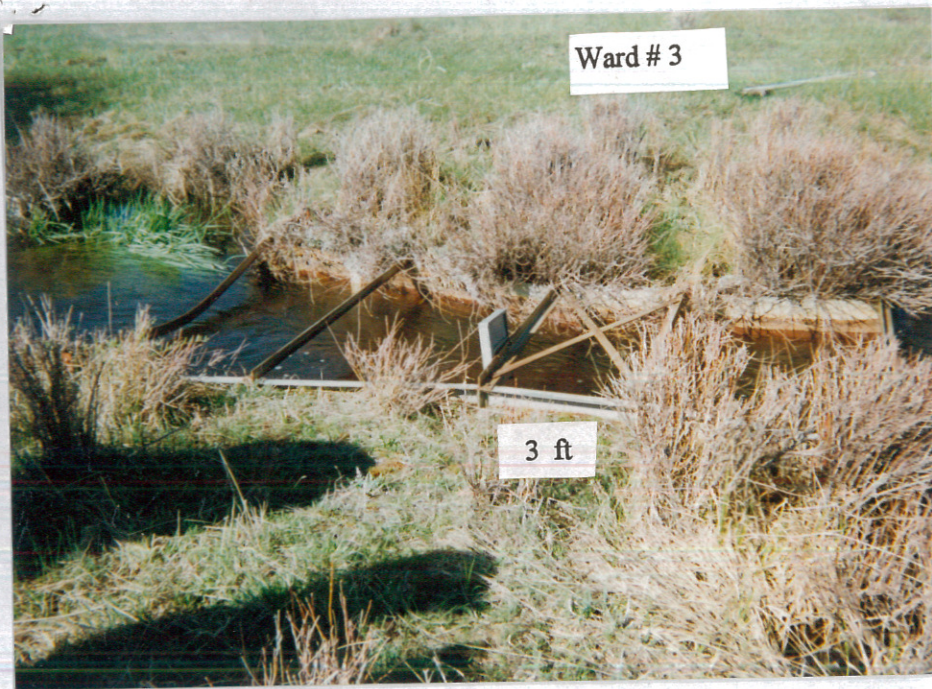
Oklahoma #1



5 ft

Oklahoma #1





square wooden headgate

submergence created by  
grasses in channel, needs to  
be raised 4".



Riddle Ditch

4 ft

not level & not aligned

set too low, raise 4 - 6",  
measured = 5.4 cfs  
predicted = 9 cfs



Kent Holt

# STATE OF COLORADO

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## Estimating Parshall Flumes Discharges Using the Famous Division 6 Chip Test

The Parshall flume is the primary device used to measure the amount of water flowing through an open channel water delivery system. Properly installed, these devices are both accurate & reliable. The following procedure has been used in Division 6 to determine the approximate flow through a Parshall flume that is out of level or submerged.

Using a only stop watch an observer should be able to determine the flow in a flume under most conditions to within about 10-15 percent.

$$Q = (HK) / T$$

where H=gage height

K=throat width coefficient

T=time

The gage height is the average reading for both sides of the flume taken at the normal location within the converging section. The throat width coefficients are as follows:

THROAT WIDTH(ft)	K
1.0	8
1.5	10
2.0	13
2.5	16
3	19
4	26
5	37
6	48
7	59
8	70

The time is the mean time for a floating object such as a wood chip or stick to travel through the converging section of the flume. Generally I would time 5 "chips" going through the converging section. Throw out the high and the low and then average the remaining 3 readings.

KH